The Xtal Set Society Newsletter

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A “Well Grounded” Education?

By Dan Petersen, W7OIL

Here’s a question or two for the younger reader – why do we “dial” a phone number? And what is a “dial” anyway? Well, back in the era called BC (Before Computers) things were a bit simpler. While we weren’t squatting around a fire in front of the cave and eating raw meat we did have things that are recognizable today. Cars were chrome-plated road boats, slide rules were used to invent the A-bomb and to travel to the moon and the telephone was a squat device on the desk with a round rotary assembly on it’s front. This was a “dial” and you used it to dial your desired phone number. This dial was actually a switch that, when you put your finger into a number hole and spun the dial until your finger came up against the “dial stop” (remember this term). Then you released it and the dial spun back to rest. While it returned the telephone sent a series of pulses corresponding to the number to the phone company. Don’t even get me started on how long distance phone calls were made!

So what does this have to do with the upcoming election, and don’t get me started on *that* either. The title of this article may provide a clue. It’s about grounding and what you can do about it. In this hobby of crystal and tube, transistor, etc radio construction using a ground connection is as important as an antenna. For without it you are making the sound of one hand clapping.

Definition: In electrical engineering, **ground** or earth is the reference point in an **electrical** circuit from which voltages are measured, a common return path for electric current, *or a direct physical connection to the Earth.* The “direct physical connection to the Earth” part is the one we are interested in here. Now, It is not generally thought that the ground (“earth” to my English reader) could be a conductor of electricity. While not as efficient as a silver wire it can and does conduct electricity. In 1837 Carl Steinheil discovered that the earth itself could be used as a conductor, which led to the development of the “single-wire” telegraph. Samuel F. B. Morse latched onto the idea and developed a *practical* telegraph system. The system in figure 1 is representative. A single wire and a return through the earth connect the two stations. The resistor “Rg” represents the resistance of the ground. This, in this case, was over 10,000 ohms so it took over 350 volts of battery power to overcome the ground resistance! Keep your fingers clear of the metal parts!

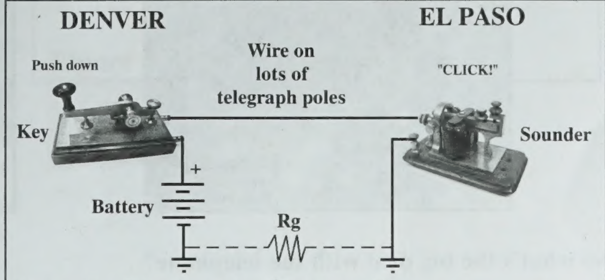


Figure 1 - The Practical Telegraph

Is this train of thought going somewhere?

Radio stations do not depend on a wire to deliver energy to a radio receiver. However, the radio signal, like any electrical circuit requires a return path and, you guessed it, it's the earth. At radio frequencies the antenna above ground has a kind of "mirror image" in the ground. While not a real antenna some way must be made to connect to this "mirror". That is where the ground connection comes in. In the early days of radio connecting grandpa's venerable crystal set to ground was a must. But what made a good ground connection? One of the easiest ways was to connect the ground terminal to a metal *cold water* pipe. Not hard to do in the 1920□s when water pipes were copper or cast iron. Most water pipes today are plastic □ ABS or PVC so that is not a viable way to go. A ground connection to a cold water pipe should be made as close to where the pipe enters the ground as possible. The ground wire should be as heavy a gauge as possible. The ground wire in Figure 2 is at least □ought□ or □double-ought□ gauge. Copper braid works well too as long as it is at least ½ inch wide.

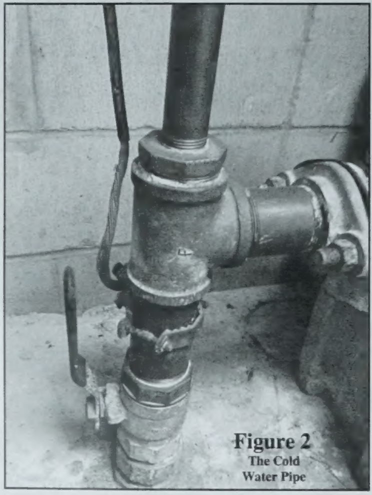


Figure 2
The Cold Water Pipe

So what's the big deal with the telephone?

Telephone companies, or in those days THE telephone company (Ma Bell) was pretty finicky about good grounding. They still are. A poor or rectifying ground could raise havoc with the voice circuits. The little metal "dial stop" on the phone dial was connected to Ma Bell's extensive ground system. When I was a kid I used to connect my crystal sets ground to the dial stop on "the" phone. Yes, one phone, in the kitchen. The antenna wire went out the kitchen window. Mom made me disconnect everything when she wanted to use the phone so she wouldn't get electrocuted. Never question Mom-logic.

No metal cold water pipe? Never fear, this is where the *ground rod"* comes in handy. Just about any plumbing supply or electrical distributor sells ground rods. These are (usually) eight feet long, are made of galvanized steel or copper and have some way to fasten the ground cable securely. Figure 3 shows a typical installation. This ground rod is copper and has a ground wire with green and yellow striped insulation connected to it. The green and yellow color is reserved for ground connections to earth ground. Only about the top six inches of the ground rod is showing. It has been pounded down seven-plus feet into the earth. This can be cause for concern if you live in an area where it may be easier to pound the rod into the face of Hoover Dam than into your back yard. I am lucky here next to the Columbia river – I live on top of a thousand feet of silt. Hardly a rock to be found. I can push a ground rod halfway into the ground by hand before I have to start hammering!

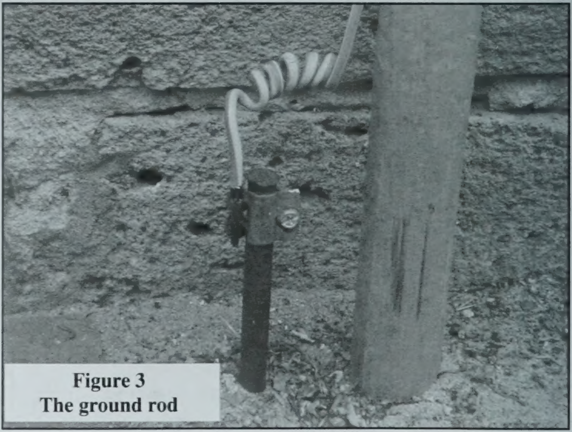


Figure 3
The ground rod

Non-Ground rod solutions

Sometimes there is just no way to install a ground rod or connect to a cold water pipe and the venerable dial stop has gone the way of the celluloid collar and the whalebone corset. One solution is the "counterpoise". This is a series of wires (or even one wire) that is used in lieu of a ground rod. Most radio broadcast radio antennas have an array of wires extending out in a radial pattern from beneath the antenna. Figure 4 shows a "radial pattern" counterpoise extending from below the antenna. The illustration shows 40 radials, which would be the case for a broadcast station but the average crystal radio usually doesn't need anything so elaborate. The counterpoise acts as one plate of a capacitor while the earth itself acts as the other. This demonstrates that not only can you make a resistive contact to ground but a *capacitive* connection too. A fellow I know who lives four floors up in an apartment uses a novel counterpoise. He has a piece of chicken-wire under the large rug in his living room. While not ideal it gives him some capacitive connection to ground and it is certainly better than nothing. Even a single wire run across the ground works, as evidenced by one ham dragging a counterpoise wire behind him while he operates his transceiver as he is hiking. His antenna is a base-loaded 10-foot whip.

A caution to the wise:

My amateur radio station is in a "No antennas" retirement village. I do however have a 20-foot flagpole that, upon closer inspection, is my main antenna. Underneath it there is a galvanized ground-rod and a series of radials connected to the ground rod. This works quite well but you do not want to do as another ham did not long ago. He installed a nice radial system with a central ground rod like mine but he drove ground rods into the ground at each free radial end and connected the free ends of the radials to them. Bad move. Now you have a wire extending between two ground points. No two ground points have the same voltage potential referenced to one another so you get a small current on the radial wire. That can introduce huge amounts of noise into a radio receiver. The lesson was learned after a lot of work. The counterpoise wires do not have to be bare wire and as a matter of fact I prefer using insulated wire as it is protected when buried in the ground. You do not need to bury the counterpoise in the ground but to protect it from being tripped over and yourself from being tripped burying it is a good idea. Mine is under 2 inches of gravel in the back yard.

What about the ground connection in a wall outlet? Those can be noisy and unreliable as a *radio* ground although they are fine for the power grid and grounding appliances. The neutral wire is worse. While it is supposed to be at ground potential it is a grounded conductor, not a grounding conductor. The difference? A grounded conductor is meant to carry current while a grounding conductor is not supposed to carry any current. It is a safety device.

I hope this article clears up some questions about grounding. As an electrical engineer who dealt with grounding issues I have found that volumes can be written about grounding and some of it in my estimation also includes a bit of black magic. Enjoy experimenting!

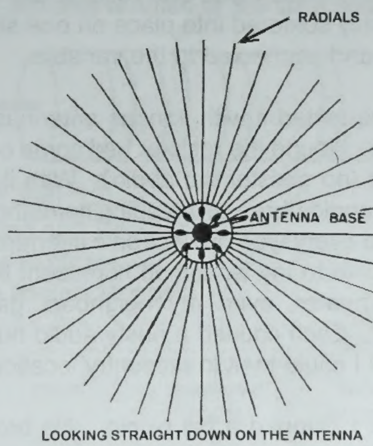


Figure 4 Radial counterpoise system

The Ugliest Little Crystal Set

By Mark Rose

About three years ago my son and I were at the Antique Radio Club of Illinois "Radiofest" flea market searching for old and interesting crystal radios. Word got around among the dealers and one eagerly waved us over.

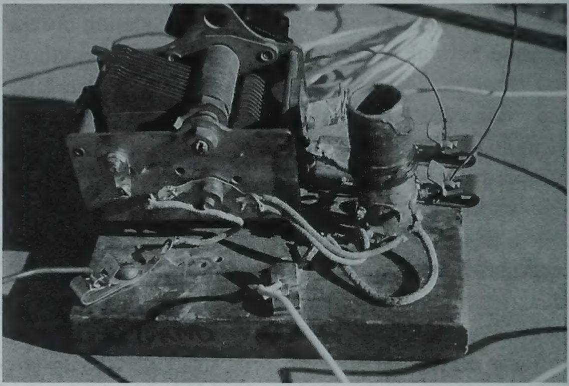
The radio he showed us was crude and dirty. I was about to say no thanks when my son said it might have potential. I went with his judgment and paid the dealer his price. (these folks could sell you anything!)

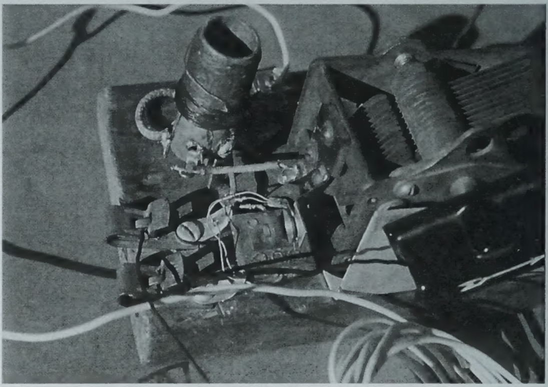
Upon getting it home, I examined and realized it was made from salvaged components of various vintages. A large variable, a mica capacitor across the phone circuit, and a little coil with a possible rewrapping of wire over a factory wrapped and waxed winding. The diode and resistor are modern and freshly soldered into place on one side of the phones and connected to the variable.

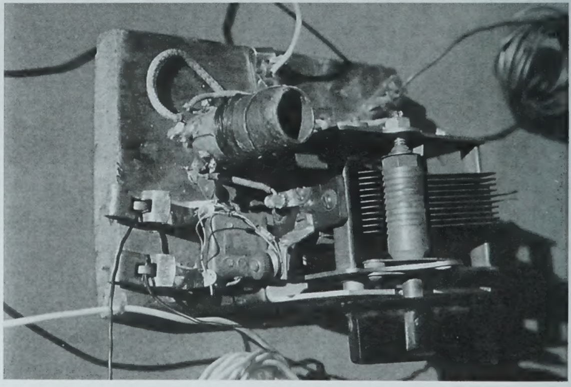
But when we tested it with various antennas, we got no audio. I found the resistor had come off the binding post (no resistor, no audio). With it connected I got audio (three overlapping flamethrower stations) and every type of electronic interference. It was sensitive to my workshop florescent lights, an electric heater, even my neighbors garage door opener. Each caused a nasty audio hum. I shelved it till I could try it in a country location.

My wife and I planned a fall picnic. We brought a blanket, fine wine, cheese, bread, and this little crystal radio. The radio was an afterthought and in my rush to leave, the two spools of wire I grabbed to bring along as a ground and antenna turned out to be just seven feet long each. The location was a freshly cut hay farm 28 miles from Chicago and 12 miles from the three high power station towers. I draped the antenna wire up over a round hay roll and laid the ground wire out and staked it with my pocket knife.

With just seven feet of antenna wire we got decent volume and it was now tunable with distinct spaces between the three dominant stations. Unfortunately all three stations were talk radio. Fortunately the wine and cheese made it bearable. In the right settings this crude little radio has its strong points. We store it in the truck's tool kit as a take-along radio for trips to the country.







For The Electronics Beginner

By Xtal Staff

OHM's LAW

Most electronic equipment consists of a power supply or battery, transistors or ICs, connectors, a case, and three types of passive components called resistors, capacitors, and coils (inductors). This note covers the basics about the resistor.

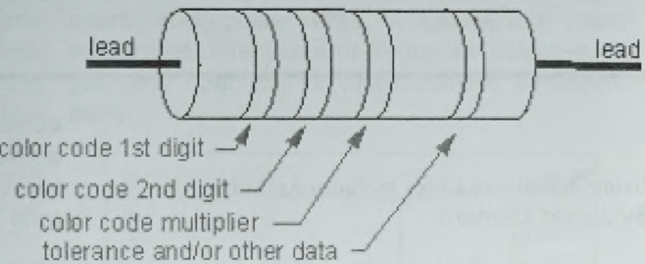
George Ohm wrote a paper in 1826 describing the relationship between the voltage applied across a resistor and the resulting current flowing through it. In honor of his early works, we call this relationship Ohm's Law. The law can be expressed as a ratio as follows,

$\frac{V}{I} =$ **R, where V is the voltage in volts, I the current in amperes, and R is the resistance in ohms.**

For most resistors, R is a constant. The value of R depends upon the resistivity of the material used and its size and shape.

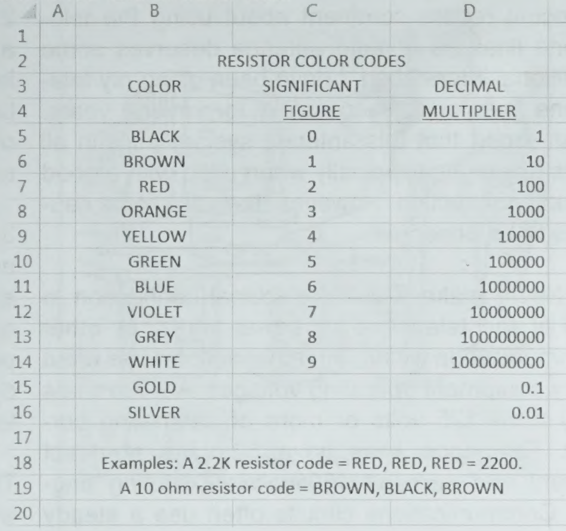
Resistors that you can purchase from a retail outlet, such as Mouser on line, vary in size. A common physical size is the ¼-watt carbon film resistor noted in the drawing. Manufacturers make resistors in a range of standard values, using two digits and multiplier and these are represented by three color bands printed on the resistor as noted in the drawing.

the resistor... its value is noted by the color code



For example, a 100 ohm resistor is represented by brown (1) and black (0) color bands plus a multiplier of brown (10). We interpret this brown-black-brown color code as 10 times 10 or 100 ohms. The full range of color codes and multipliers is shown in the table.

Now let's check out the color code for a much larger resistor, say 220k ohms. What's k stand for? It's an abbreviation for 1000 and is used to avoid righting a bunch of zeroes. For example, 220k is the same as writing 220,000 but we avoid writing all those zeroes. This is common practice for experienced hobbyists and techs. Now let's map out the color code. We need RED for the first 2, RED for the second 2 and YELLOW for the four zeroes needed (note that 0 and k is the same thing as 4 zeroes and therefore pick yellow).



RESISTOR COLOR CODES

COLOR	SIGNIFICANT FIGURE	DECIMAL MULTIPLIER
BLACK	0	1
BROWN	1	10
RED	2	100
ORANGE	3	1000
YELLOW	4	10000
GREEN	5	100000
BLUE	6	1000000
VIOLET	7	10000000
GREY	8	100000000
WHITE	9	1000000000
GOLD		0.1
SILVER		0.01

Examples: A 2.2K resistor code = RED, RED, RED = 2200.
A 10 ohm resistor code = BROWN, BLACK, BROWN

An Application

Now that you know how the resistors are color coded, let's attach a resistor to a 1.5 volt battery and use Ohm's Law to determine how much current and power the resistor will demand.

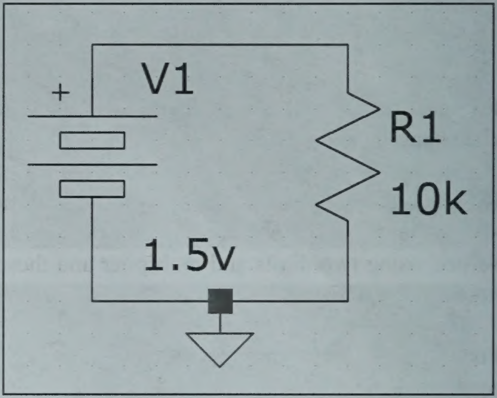
When the battery voltage is applied to a resistor, a current flows through the resistor and back to the ground lead of the battery. Rearranging the equation for Ohm's Law introduced at the beginning, we can solve for the current heating up the resistor.

$V/I = R$ rearranged is

$$I = V/R = 1.5/10k = 1.5/10{,}000 = 0.00015 \text{ amperes} = 0.15 \text{ ma.}$$

10k represents 10,000 ohms since k represents 1,000 ohms so the current is 0.00015 amperes. Circuit designers prefer to work with numbers that have fewer zeroes so convert the amperes to milliamperes, abbreviated as ma.

The power consumed in a resistor is obtained by multiplying the voltage across it by the current through it or by squaring the current and multiplying it by the resistance. The former is easier in this example. So, multiplying 0.15 ma times 1.5 volts gives us the power consumed in the resistor of 0.225 milliwatts or roughly a ¼ mW!



Using Telephone Lines as radio Antennas

By James Barnard

A recent reader comment about using the telephone lines as a radio antenna deserves some additional information. I have been using my telephone lines quite successfully for several years. I can report that this antenna system pulls in all sorts of signals especially when used with a good ground connection. However, there are some cautions to be observed.

1. Never make a direct electrical connection to any of the telephone or power wires, or other communication wiring. Interconnection wires often carry equipment operating voltages. AC line wires may have 125 volts or more of alternating current. Telephone lines have 50 volts of direct current and perhaps 150 volts AC during ringing. Communications circuits often use a steady current to indicate that the remote devices are actively connected. Any radio attached to these wires could route hazardous power through itself (and through its user)!

2. Electric and telephone lines are usually balanced with respect to ground to reduce noise and interference. Connections that are not properly balanced may result in poor or non-performance of the equipment (blown fuses, distorted audio, no telephone ringing, data errors, etc.).

3. Fault conditions occur on public wiring: Storms and vehicle accidents can damage support poles, allowing wires to cross and place unusual voltages on connected devices. Lightning strikes can put spikes of many thousands of volts on a line, damaging equipment and starting fires. Surge protectors limit but do not eliminate voltage spikes.

The only safe way to make use of the public wiring is to use an isolated connection method.

The device must pass radio or audio frequencies safely to your receiver without allowing any of the undesired voltages into your circuits. Here is the method that I have used successfully many times.

Materials: Obtain a length of UTP (Unshielded Twisted Pairs) network cable, say 6 to 10 feet (2 to 3 meters). No modular end plugs are needed. Contractors who install communications wiring usually have pieces of cable this size left over after completing a job, and may give them to you at no cost. Home electronics stores often have reels of this cable and will sell it in small lengths. Any grade (Category 4, 5, 6, etc.) cable will do since we are not going to use it for its intended purpose, so get the oldest grade available. Jacket color and conductor size are unimportant.

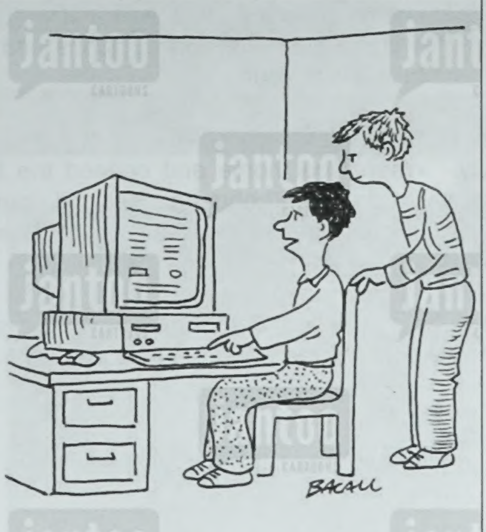
Preparation: Remove about 1 inch (2.5 cm) of the outer jacket from each end of the cable, exposing 4 twisted pairs of wire. Carefully untwist each pair of wires so that there are now 8 individual wires protruding from each end of the cable. At only one end of the cable, cut each of the white wires with a colored stripe flush with the end of the cable jacket. Be cautious not to damage the insulation on the remaining wires. At the other end of the cable, cut each of the solid color wires flush with the cable jacket. The cable will now have four individual striped white wires at one end, and four solid color wires at the other end. Remove 1/2 inch (1.2 cm) of insulation from each wire. Twist all four of the striped white wires together to form a single wire with four strands. At the opposite end of the cable, separate the four solid color wires so that they do not touch each other.

Installation: Newer telephone wiring uses modular plugs and wall or panel mount equipment jacks. Replacement plugs or cords are available for these jacks. Older telephone wiring used a cord attached to screws on a terminal block. Remove the block or plug cover. Fasten one of the cable's solid color wires to each terminal. Since there is no direct path through the cable wires, color coding is not important. Be certain that none of the bare wire ends touch each other. When the cable wires are all attached, replace the cover.

Operation: Attach the four white striped wires to the receiver antenna terminal or to the whip antenna. Use an additional wire to attach the ground terminal to a cold water pipe. (If no water pipe is available, use the center screw on an AC wall outlet cover.) Route the antenna cable and the ground wire away from power cords and other cables. Do not coil the cable or ground wire.

Note 1: Outside telephone wiring is a grid of many wires, some of them many miles long. Long wire antennas can produce extremely strong signal levels from powerful local radio stations. Too much signal may cause a radio to be unable to tune out the local stations. Add a series resistor between the antenna cable and the receiver to attenuate the voltage. Use a shorter length of UTP cable if receiver overload persists.

Note 2: The antenna cable may not be satisfactory with underground outside telephone wiring or nearby noisy power wires. Telephone wire antennas are not directional or frequency selective, so you may hear two or more stations simultaneously.



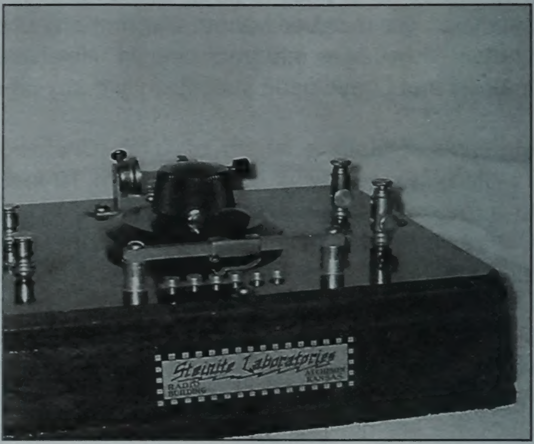
jantoo

"I downloaded music from a radio station in South Korea, and I got Seoul music."

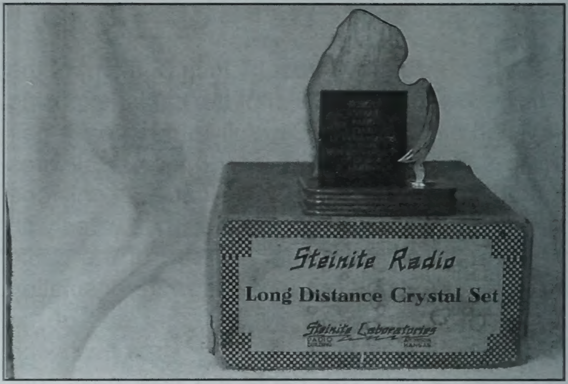
Xtal Corner: Member Correspondence

Greetings from Harvey

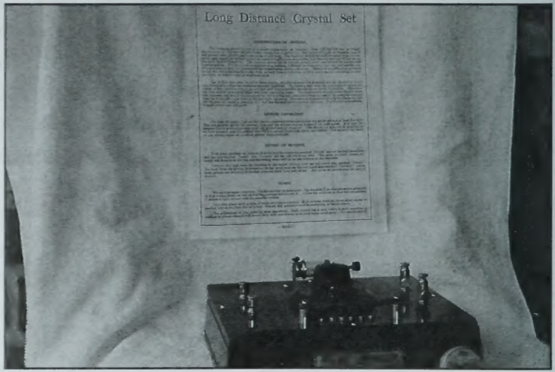
I thought you should share this beautiful piece of Kansas engineering! In the late 1970's I stopped at a garage sale which I thought was a wasted effort. On the way out I noticed this Steinite Box on top of a food freezer. I asked the proprietor if the box was full and he said someone bought the contents but did not want the box.



A few years later on my way home from work, I stopped at a yard sale some miles from the other sale. I found dishes, children's toys and nothing of interest. A young man came up to me and asked if he could help. I told him I was looking for old radio stuff. He said, "I bought one at a garage sale a while ago and never could get it to work." He then asked if I would like to see it. Here was the xtal set from the empty box!



After agreeing on dollars, I left there with the receiver and went back to where the box was. The same people were still living there and I asked about the box on the freezer. He said that after the sale, all that was left went into a dumpster, but I could go look if I wanted to. It was still there plus some dust after many moons and he said just take it with you!



Long Distance Crystal Set

I realized as soon as I picked it up that it was not empty. When I got home and opened the box there was a dual 2000 ohm headset, the operating instructions, and a nice round tin of Steinite crystals.

Having been a radio collector and service person for many years, this was a very nice addition.

From: Terry Lutz
I would like to build a toroid coil crystal radio according to the plans given on line by John Fuhring. He specifies using two T80-15 toroid cores for this set. Could I substitute a FT82-61 for the T80-15 and still get similar results with the same number of windings? Thank you in advance for your consideration.
Terry Lutz

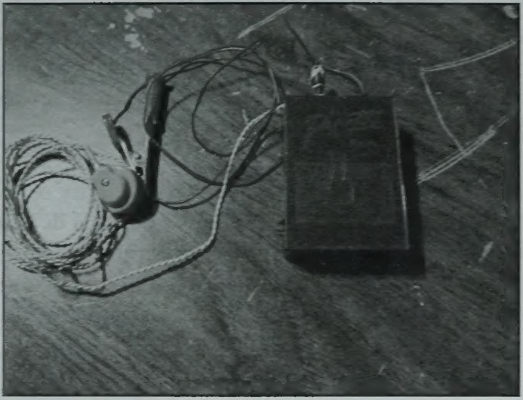
Terry,
I have never used the T80-15; we always use the FT82-61 toroids that we stock for sale on our website, www.midnightscience.com. I don't see why it wouldn't work. Good luck and let us know. Phil

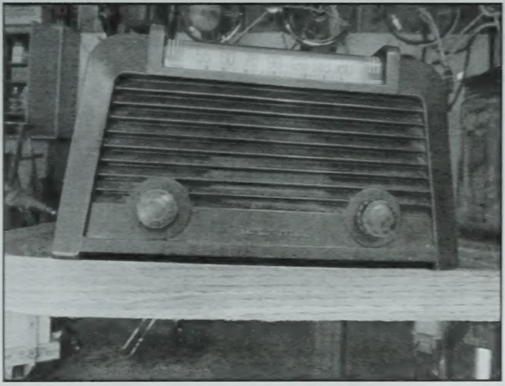
From: Joe Lynch
Hello,
I found your site on the internet. We recently downsized to a condo (top floor 12) in Kansas City, MO.. When we were moving I found my old crystal sets. They are in really good shape. One is MRL no. 2-A from Elmer Osterhoudt. I'm hooked on the hobby again.

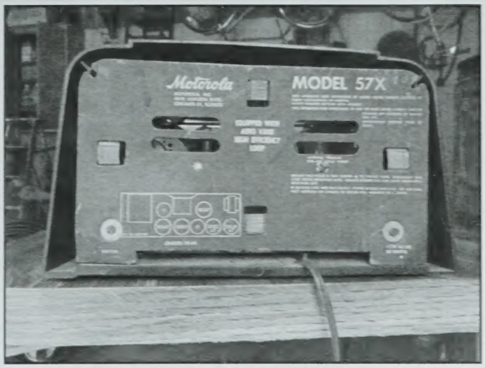
My question is: Will these sets will work in my current location? I have to be careful when using an antenna, but I think I can overcome this with hidden wire. The condo police can be tough and ignorant. My main problem is what to use as a ground. Any help would be most appreciated. Thank you.

HI Joe,
Just run a second wire out in the opposite direction if you have the room. You could also run a ground wire around the baseboard in your room and then run the antenna – attach with tape - around the ceiling of the room. Try that and good luck. Phil

Editor Note: These photos are Ken Ladd's radios the he talked about in the last issue. Several people commented about how much they liked his story so I wanted to share these pictures as well.







Detector Loading

Xtal Staff

For all crystal sets (that can truly be called crystal sets) some sort of passive AM detector circuit is used. The most common configuration is shown in Figure 1, consisting of a detector diode (D), a capacitor (C), and a resistor (P) (the resistance of the headphones). In fact, this circuit is still one of the most widely used demodulators for AM signals; almost every modern day superheterodyne AM receiver has one.

In order to optimize a crystal set for selectivity or volume, it is useful to realize how this basic AM detector loads the tuned circuit. The detector, in fact, can be modeled as a resistor. As such, we can substitute the resistor for the detector and easily calculate its effects on the L-C circuit.

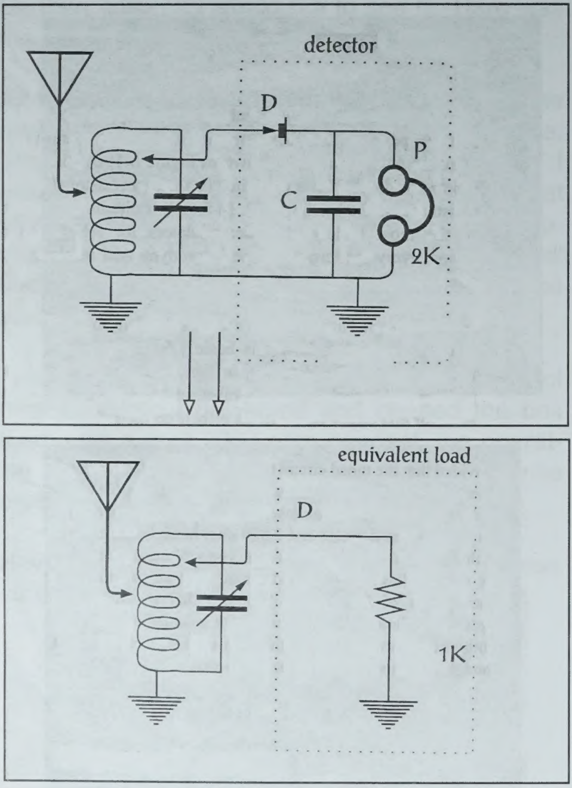


Figure 1

Provided that the tuned circuit Q is high enough (>5), there is a neat and simple rule of thumb we can use: The value of the resistor is one-half the headphone resistance. For example, if you remove the detector and 2,000 ohm headphones and put in their place a 1,000 ohm resistor, you will measure exactly the same voltage at the tuned circuit with an oscilloscope! The bottom of Figure 1 illustrates that a resistor can replace the diode and headphones for calculation purposes. Both circuits are identical if the Q of the L-C circuit is high enough, and this is usually true in practice.

Studying figure 2 will reveal why this simple rule of thumb is plausible. Assume that a steady RF signal is introduced to the crystal set. The figure shows the DC current developed at the detector, and it displays the current spikes that recharge the capacitor back to a DC voltage level each RF cycle. The RF signal current at the operating frequency has a steady- state amplitude that is twice the DC current. This can be shown to be true by expanding the diode current (the spikes) in a Fourier Series (Clarke, 1978). Hence, the tuned circuit, at the operating frequency, "sees" a load resistance that is one-half that seen by the DC current.

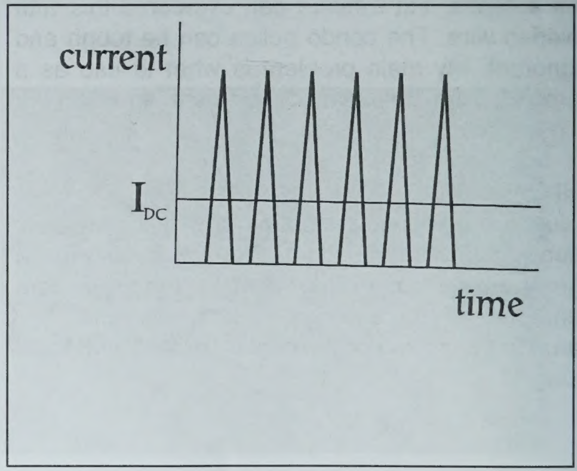


Figure 2

Call: 405-517-7347 Xtal Set Society www.midnightscience.com

P.O Box 3636 Lawrence KS 66046 xtalqm@gmail.com

Description		Cat#	Qty	Price
Subscription The Xtal Set Society 1 year				14.95
Subscription Canadian 1 year (in US dollars)				15.95
Subscription International 1 year (in US dollars)				21.95

Shipping (delete if subscription ONLY) 1st class mail 1-2 items $5.95, 3-4 items $7.95, 5 or more items $8.95.

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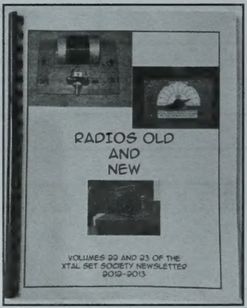
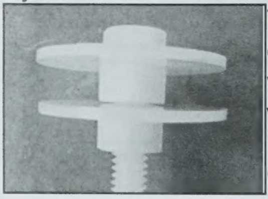


RADIOS OLD
AND
NEW

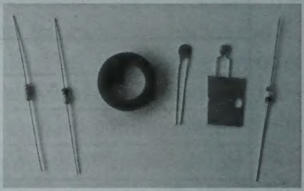
VOLUMES 22 AND 23 OF THE
XTAL SET SOCIETY NEWSLETTER
2012-2013

RADIOS OLD AND NEW is volumes 22 and 23 of the Xtal Set Society Newsletter. A wide range of topics and projects are covered in 2012: aerials circa 1917, experiments with regens, grounding and reducing noise in your station, experimenting with spider coils, a 2 for 1 regen set, primer for the 602 mixer at 40 kHz, a modern TRF AM receiver. The following topics for 2013 are: JFET Drain-Output set, a foxhole radio, feedback for beginners, a modern day regen, the universal crystal set, The Albert Hull Memorial Dynatron Regenerative Receiver, adding absorption wave traps, from telegrapher to coherer, a 700 Hz oscillator featuring a quadrature architecture, and more. Vol 23 $15.95

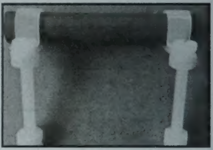
Nylon Form for Core



These nylon plastic pieces combine as a form for the various ferrite toroid coils we offer. The form is low loss thus preserving the Q of the coil wound on the form. Extending them above the chassis - which might be metal or fiber board also preserves the coil Q. nycorefrm $2.50

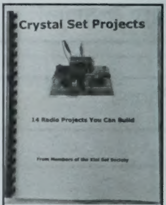


R-L-C-D Assortment
This assortment has nearly all the parts to build a basic am crystal set: 100 pf cap, 330 pf cap, am-band toroidal coil form (ft-82-61), 47k and 100k resistors and a 1n34 diode. RLCD 5.95



Nylon Form for Rod
This set of nylon parts combine as a form for the ferrite rod, thus preserving the Q of the rod mounted above a chassis. The Rod is not included. Nylon Form rod $2.50

Crystal Set Projects You Can Build is a collection of 14 radio projects designed by members of the Xtal Set Society. The members hope that by creating this book they will help others to discover this great hobby while at the same time learning basic radio concepts. Here's a sampling: Low Budget Xtal Set, A Loop Antenna Crystal Set, The Den Two Crystal Set, Build a Matchbox Crystal Radio, The triple Tuned Crystal Set and more. XCP $12.95



Crystal Set Projects

14 Radio Projects You Can Build